CLAIMS LISTING WITH SELECTED AMENDMENTS

Please reinstate claims 10-22 as claims 73 and 75-86, which include claim amendment (of claims 73, 75-79 and 83-86) from their previous embodiments. The following listing of claims supercedes all previous listings of the claims. A new claim 74, which depends from reinstated claim 73 is also presented, as a result of an amendment to reinstated claim 73. No new matter is introduced by the amendments.

1-27. (Canceled)

28. (Previously added) Method of multidimensional cardiac monitoring, comprising the steps of:

positioning a plurality of physiologic signal sensors at geometrically distinct positions on a body relative to a heart, each one of the sensors coupled to one of a plurality of signal channels via one or more leads;

acquiring via the signal sensors multidimensional physiologic (MP) signals from the heart; and

deriving from the acquired MP signals output data, said output data representative of cardiac electrical activation events and including signal information not encompassed by any single signal channel.

29. (Previously added) The method of claim 28, wherein the deriving step further comprises the step of:

extracting from the acquired MP signals undesirable signals attributable to distal, global and external signal sources through comparison of the undesirable signals acquired on two or more of the signal channels so as to isolate a local cardiac signal.

30. (Previously added) The method of claim 29, further comprising the step of:

externally generating on one or more of the signal channels one or more signals containing information relative to external undesirable signal sources.

31. (Previously added) The method of claim 29, wherein:

the undesirable signals comprise respiratory baseline artifacts; and

the extracting step further comprises the steps of

analyzing the MP signals through a low frequency curve fit or filter to determine the respiratory baseline artifacts, and

subtracting the respiratory baseline artifacts from the MP signals.

32. (Previously added) The method of claim 28, wherein:

each signal channel is coupled to a sensor by a plurality of electrically conducting leads of similar trajectory not all of which are in electrical contact with the sensor, such that a common spurious signal is acquired in each lead attributable to signal sources external to the body; and

the deriving step further comprises the step of extracting the common signal from the acquired MP signals.

33. (Previously added) The method of claim 32, wherein the plurality of electrically conducting leads are twisted.

34. (Previously added) The method claim 28, wherein the deriving step further comprises the step of:

comparing the acquired MP signals to stored data to determine what aspects of the acquired MP signals are useful for generation of the output data.

35. (Previously added) The method of claim 34, wherein the stored data comprise a plurality of signal sources such that the comparing step distinguishes local, distal, global or external signal contributions to the MP signals.

36. (Previously added) The method of claim 34, wherein the stored data comprise electrocardiogram data obtained in the absence of one or more undesirable signals.

37. (Previously added) The method of claim 28, further comprising the step of:

outputting the data output, the data output including an indicator relative to the duration of one or more cardiac cycles so as to permit corrections for variation in a cardiac filling period.

38. (Previously added) The method of claim 28, wherein the deriving step further comprises the steps of:

determining if the MP signals fit constraints reflective of the expected temporal evolution of the MP signals and defining acceptable variations relating to one or more of the following: noise spikes, scaled or corrupted signal channels, aberrant heart beats or otherwise unreliable data; and

editing the MP signals to fit the constraints if said MP signals do not fit so as to obtain descriptive values reflective of desired signal features.

39. (Previously added) The method of claim 38, wherein the deriving step further comprises the step of:

fitting feature template components determinative of output data information content to the descriptive values so as to generate the output data.

40. (Previously added) The method of claim 38, wherein the constraints include one or more of the following: previously acquired MP signals from the same heart, expected cardiac cycle averages and variance values, empiric data, data previously acquired by scanning prior ECG's, data acquired from one or more other patients indicating expected co-variant ranges, patterns and parameters, or data collected on gradient effects or magneto effects of medical equipment.

41. (Previously added) The method of claim 38, wherein the desired signal features include one or more of the following: P-wave, R-wave, ST-segment, T-wave, respiratory phase from baseline artifact, and wave morphologies.

42. (Previously added) The method of claim 28, wherein the cardiac electrical activation events include one or more of P wave, R wave, QRS wave, ST segment deviation, T

wave, respiratory cycle baseline artifact, beat-to-beat and other temporal wave morphologies.

43. (Previously added) The method of claim 28, further comprising the step of:

computing from the output data running average values for repetitive cardiac electrical events over a pre-selected time period.

44. (Previously added) The method of claim 28, further comprising the steps of:

comparing the output data to historical cardiac information to determine if the heart filling interval is uniform or non-uniform; and

setting indicators if the heart filling interval is non-uniform.

45. (Previously added) The method of claim 28, further comprising the step of:

generating from the output data a synthetic ECG signal including indications of cardiac electrical activity.

46. (Previously added) The method of claim 45, wherein the synthetic ECG signal includes a superimposed R-wave spike and ST segment deviations that have been corrected for baseline artifacts and magneto effects.

47. (Previously added) The method of claim 45, further comprising the step of:

providing a means within the synthetic ECG signal permitting measurement of ST segment deviations even in the presence of magnetic disturbances.

48. (Previously added) The method of claim 45, further comprising the step of:

pre-defining morphological rules to which the synthetic ECG must conform.

49. (Previously added) The method of claim 45, further comprising the step of:

offsetting one or more segments of the synthetic ECG signal to permit identification of the presence of or changes in ischemia.

50. (Previously added) The method of claim 28, further comprising the steps of:

forecasting, based on the output data, heart filling intervals; and

identifying instances of comparable heart position for image collection based upon the heart filling intervals.

51. (Previously added) The method of claim 28, further comprising the step of:

determining patient respiratory cycles from baseline artifact undulations in the MP signals.

52. (Previously added) A multidimensional cardiac monitoring system (MCMS), comprising:

a plurality of physiological signal sensors positioned in geometrically distinct positions on a body relative to a heart, the sensors acquiring multidimensional physiologic MP signals from the heart;

a plurality of signal channels coupled to the sensors; and

a data processor coupled to the signal sensors that derives from the acquired MP signals output data representative of cardiac electrical activation events and including signal information not encompassed by any single signal channel.

53. (Previously added) The MCMS of claim 52, wherein the data processor extracts from the acquired MP signals undesirable electromagnetic signals attributable to local, distal or external signal sources.

54. (Previously added) The MCMS of claim 53, wherein each of the signal sensors is coupled to a one of the signal channels by a plurality of electrically conducting leads of similar trajectory not all of which are in electrical contact with the sensor, such that a common spurious signal is acquired in each lead attributable to signal sources external to the body.

55. (Previously added) The MCMS of claim 54, wherein each lead is twisted.

56. (Previously added) The MCMS of claim 52, wherein one or more of the signal channels contribute signals generated externally from the heart and providing information relative to the external signal sources.

57. (Previously added) The MCMS of claim 52, wherein the processor compares the acquired MP signals to stored data to determine which aspects of the MP signals are useful in generating the output data.

58. (Previously added) The MCMS of claim 57, wherein the processor compares signal differences from a plurality of sources to distinguish local, distal, global or external signal contributions based on different sensitivities relating to geometric position of sensors with respect to the heart.

59. (Previously added) The MCMS of claim 57, wherein said stored data represent electrocardiogram data obtained in the absence of the generation of one or more undesired signals or artifacts.

60. (Previously added) The MCMS of claim 59, wherein the one or more said undesired signals or artifacts include magneto effects that generate voltage or current from moving fluid in arteries or veins, signal artifacts from motion in a magnetic field or from magnetic field gradient effects, or artifacts from electric or magnetic effects on signals in leads.

61. (Previously added) The MCMS of claim 52, wherein the output data includes event indicator of a cardiac event, permitting medical equipment coupled to the MCMS to function as though connected to a patient with a reliable, threshold-detectable electrocardiogram.

62. (Previously added) The MCMS of claim 52, wherein the output data includes one or more variation indicators of a cardiac cycle variations, permitting prospective or

retrospective correction for variation in cardiac filling period by medical equipment coupled to the MCMS.

63. (Previously added) The MCMS of claim 52, further comprising a pre-processor for eliminating undesired artifacts from and the editing of the acquired MP signals.

64. (Previously added) The MCMS of claim 52, wherein the derivation performed by the processor further comprises:

comparing the MP signals to training data reflective of the expected temporal evolution of the MP signals to derive descriptive values reflective of desired signal features; and

fitting to the descriptive values feature template components determinative of output data information content to generate the output data.

65. (Previously added) The MCMS of claim 52, wherein the output data includes a synthetic electrocardiogram waveform signal.

66. (Previously added) The MCMS of claim 65, wherein a voltage offset of a continuous segment of the waveform signal permits identification of the presence of or changes in ischemia.

67. (Previously added) The MSMS of claim 65, wherein a voltage offset of a segment of the waveform signal expressed as a series of voltage spikes of full or fractional height that count out segment deviation permits identification of the presence of or changes in ischemia.

68. (Previously added) The MCMS of claim 52, wherein:

the acquired MP signals are electrocardiogram signals; and

the derived output data represents a respiratory cycle derived from baseline undulations in the acquired electrocardiogram signals.

69. (Previously added) The MCMS of claim 52, wherein sensors of magnetic gradient switching are used as reference data to eliminate or isolate their undesirable contribution to the MP signals.

70. (Previously added) The MCMS of claim 52,

wherein said coupling comprises a plurality of pairs of twisted electrically conductive leads, each pair being associated with a corresponding sensor, and a first lead of each pair being in electrical contact with a particular signal sensor and a second lead of each pair being electrically disconnected from said particular signal sensor but terminated adjacent thereto; and

further comprising a common mode rejector that eliminates from the acquired signal provided by the first lead undesired signals provided by the second lead.

71. (Previously added) A physiological sensor coupler for spurious signal suppression, comprising:

a plurality of electrically conducting leads having a similar trajectory, fewer than all of which electrically couple to a physiologic sensor adjacent to a body, such that signals common to each lead in the plurality are reflective of spurious signals generated external to the body; and

means coupled to the plurality of leads for extracting the spurious signals from the signals acquired from the sensor.

72. (Previously added) The coupler of claim 71, wherein the plurality of leads are twisted.

73. (Reinstated and amended former claim #10) Method of performing diagnostic testing of the heart and for enhancing the clarity of a display of features of interest, relating to evaluating the health of a patient's heart under examination, comprising the steps of:

~~(a)~~ positioning on the skin of a patient at geometrically distinct positions relative to the heart of the patient a set of ~~multiple~~ electrical sensors ~~pickup devices in relation to the patient's skin~~ for acquiring ~~producing~~ multivariate~~nt~~ data of the electrical activation of said heart;

transmitting ~~(b) applying~~ said multivariate~~nt~~ data to a data processor~~, which responds to receipt of said multivariate data~~; ~~and~~

~~(c)~~ comparing said multivariate~~nt~~ data with training data to derive ~~descriptive~~ values descriptive of desired cardiac electrical features; and

fitting said values~~that are applied~~ to template components to ~~, and~~ generate~~ing~~ synthetic composite ECG electrographic data for display in an easily understood view~~, indicating various heart conditions where such heart conditions may includinge the nature and/or timing of P waves, QRS waves, ST segment deviation, T waves, and/or respiratory motion~~.

74. (New) The method of claim 73, wherein the generated data indicates the nature or timing of a cardiac event selected from the group consisting of: P waves, QRS waves, ST segment deviation, T waves, and respiratory motion.

75. (Reinstated and amended former claim #11) The method of claim 73, further comprising the step of substantially reducing an artifact produced by aortic pulsations ~~that can interfere with clear readings of said synthetic composite ECG electrographic data~~.

76. (Reinstated and amended former claim #12) The method of claim 73, further comprising the steps of:

analyzing said multivariate~~nt~~ data by a low frequency curve fit or filter to extract a~~the~~ respiratory baseline artifact; and

subtracting said artifact from said multivariate data ~~it~~ to minimize the effect of said artifact on said multivariate data~~produce a flattened baseline~~.

77. (Reinstated and amended former claim #13) The method of claim 73, further comprising the steps of:

generating from said electrographic data an indicator of the ~~superimposing upward trigger spikes upon R-wave heights for ensuring that legacy R-wave detectors for following~~ timing of ~~the~~ electrical activation of large chambers of the heart; and

outputting said indicator for triggering legacy R-wave detectors.

78. (Reinstated and amended former claim #14) The method of claim 75, further comprising the steps of:

generating from said electrographic data an indicator of the ~~superimposing upward trigger spikes upon R-wave heights for ensuring that legacy R-wave detectors for following~~ timing of ~~the~~ electrical activation of large chambers of the heart; and

outputting said indicator for triggering legacy R-wave detectors.

79. (Reinstated and amended former claim #15) The method of claim 76, further comprising the steps of:

generating from said electrographic data an indicator of the ~~superimposing upward trigger spikes upon R-wave heights for ensuring that legacy R-wave detectors for following~~ timing of ~~the~~ electrical activation of large chambers of the heart; and

outputting said indicator for triggering legacy R-wave detectors.

80. (Reinstated former claim #16) The method of claim 73, further comprising the steps of:

determining if said multivariate data fits constraints which define limits of acceptable variations relating to one or more of the following: noise spikes, scaled channel, aberrant heart beats or otherwise unreliable data; and

editing said multivariate data to cause said multivariate data to fit the constraints if said multivariate data does not fit.

81. (Reinstated former claim #17) The method of claim 75, further comprising the steps of:

determining if said multivariate data fits constraints which define limits of acceptable variations relating to one or more of the following: noise spikes, scaled channel, aberrant heart beats or otherwise unreliable data; and

editing said multivariate data to cause the data to fit the constraints if said multivariate data does not fit.

82. (Reinstated former claim #18) The method of claim 76, further comprising the steps of:

determining if said multivariate data fits constraints which define limits of acceptable variations relating to one or more of the following: noise spikes, scaled channel, aberrant heart beats or otherwise unreliable data; and

editing said multivariate data to cause the data to fit the constraints if feasible if said multivariate data does not fit.

83. (Reinstated and amended former claim #19) The method of claim 73, ~~further comprising the steps of:~~

~~comparing said multivariate data to training data to identify desired features for display which can include production of P-wave, R-wave, ST-segment, T-wave, respiratory phase from baseline artifact, and wave morphologies, and~~ wherein said training data is selected from a data group representing ~~can represent the~~ features of interest, expected ranges of values and covariance as a function of time, and expected signal disturbances; and

further comprising the step of displaying said composite ECG electrographic data ~~in response to a favorable comparison~~.

84. (Reinstated and amended former claim #20) The method of claim 75, ~~further comprising the steps of:~~

~~comparing said multivariate data to training data to identify desired features for display which can include production of P-wave, R-wave, ST-segment, T-wave, respiratory phase from baseline artifact, and wave morphologies, and~~ wherein said training data is selected from a data group representing ~~can represent the~~ features of interest, expected ranges of values and covariance as a function of time, and expected signal disturbances; and

further comprising the step of displaying said composite ECG electrographic data ~~in response to a favorable comparison~~.

85. (Reinstated and amended former claim #21) The method of claim 76, ~~further comprising the steps of:~~

~~comparing said multivariate data to training data to identify desired features for display which can include production of P-wave, R-wave, ST-segment, T-wave, respiratory phase from baseline artifact, and wave morphologies, and~~ wherein said training data is selected from a data group representing ~~can represent the~~ features of interest, expected ranges of values and covariance as a function of time, and expected signal disturbances; and

further comprising the step of displaying said composite ECG electrographic data ~~in response to a favorable comparison~~.

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86. (Reinstated and amended former claim #22) The method of claim 80, ~~further comprising the steps of:~~

~~comparing said multivariate data to training data to identify desired features for display which can include production of P-wave, R-wave, ST-segment, T-wave, respiratory phase from baseline artifact, and wave morphologies, and~~ wherein said training data is selected from a data group representing ~~can represent the~~ features of interest, expected ranges of values and covariance as a function of time, and expected signal disturbances; and

further comprising the step of displaying said composite ECG electrographic data ~~in response to a favorable comparison~~.